Improvements in MIPAS ESA V7 and V8 products and trends

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INTRODUCTION

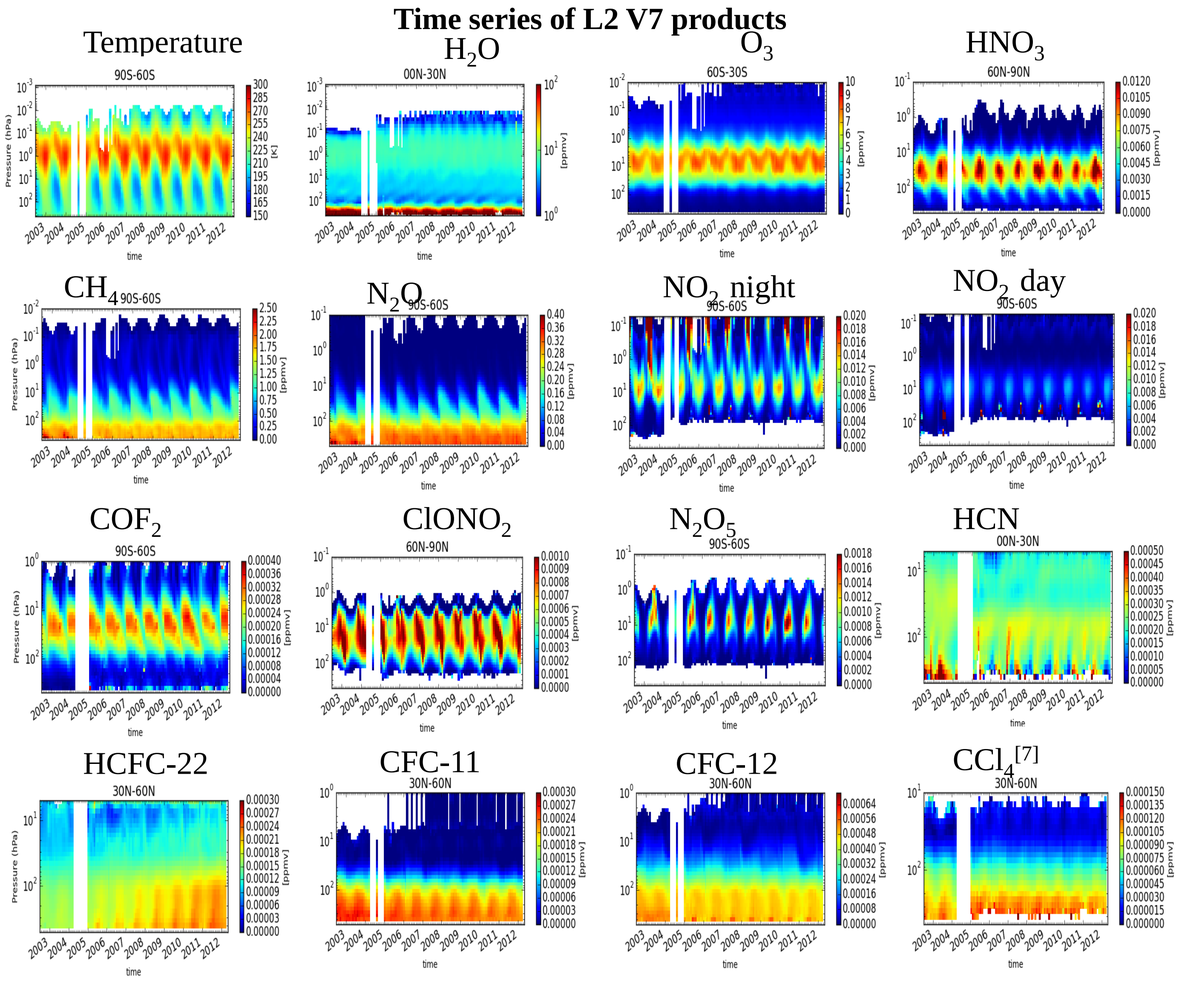
The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is a limb-viewing infrared Fourier transform spectrometer that operated from 2002 to 2012 onboard the ENVISAT satellite. MIPAS mission is divided in two phases: the full resolution (FR) phase, in the first two years of measurements, and the optimized resolution (OR) phase, characterized by a reduced spectral resolution but improved spatial resolution, for the rest of the years.

The maintenance and the upgrade of both L1 and L2 ESA processors are made in the frame of the Quality Working Group, where a fruitful collaboration among Level 1, Level 2 and validation teams can be exploited. This collaboration is essential to pursue improvements in the accuracy of the products and their characterization.

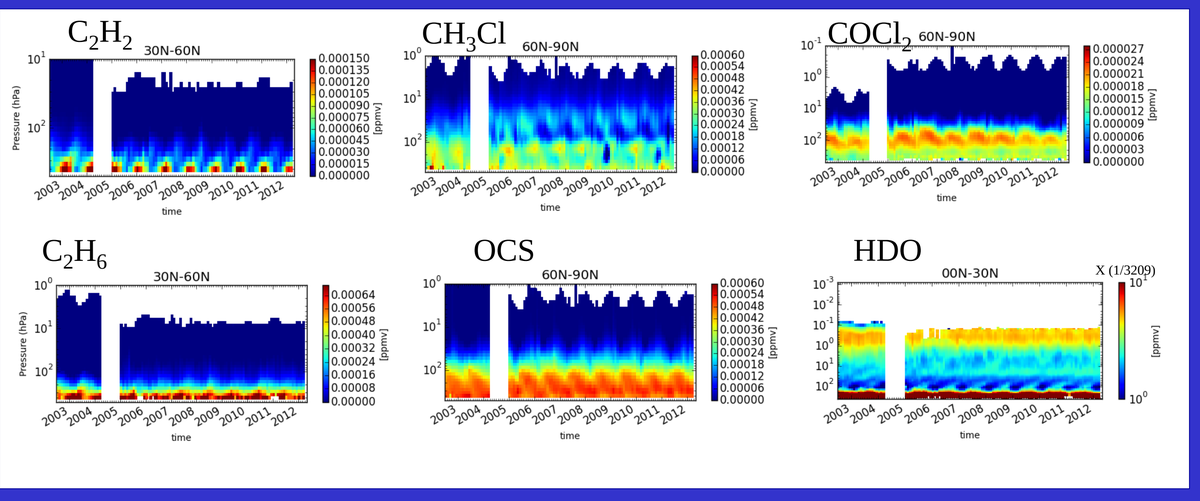
So far the full mission reanalysis has been performed with two versions of the ESA L2 processor, V6 [1] (using L1 V5 data) and, recently, V7 (using L1 V7 data), with data released in September 2016 [2]; furthermore, work is in progress to finalize a new version of the Level 2 processor (V8), that will be used for another MIPAS full mission reprocessing using the upgraded Level 1 data (V8). Each new release is characterized by improvements in the algorithms and in the auxiliary data, as well as an increased number of retrieved species.

This paper is meant to describe the additional species and the main improvements in V7 and V8 ESA L2 products with respect to previous dataset V6.

Time series of L2 V7 products

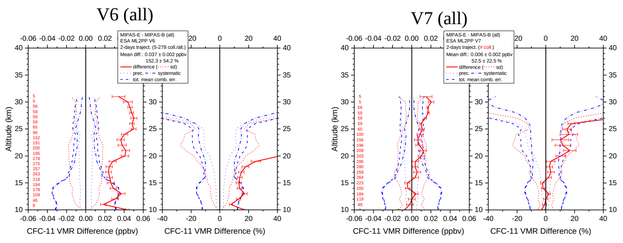


ADDITIONAL SPECIES in L2 V8 DATA (PRELIMINARY)

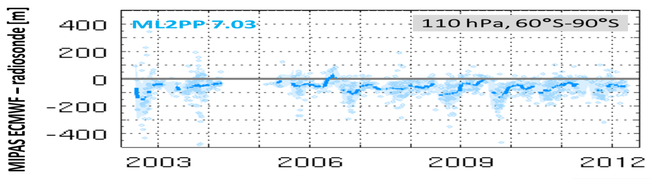


MAIN IMPROVEMENTS IN L2 V7 wrt L2 V6 DATA

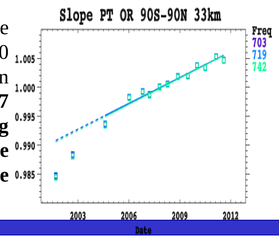
The inclusion of $COCl_2$ among the interfering species allows to **reduce the positive bias present in CFC-11 V6 measurements**. A comparison between MIPAS/ENVISAT and MIPAS/balloon for both V6 and V7 is shown ([3])



ECMWF corrected altitude are provided: these are within 200 m of ozone-sonde altitudes.

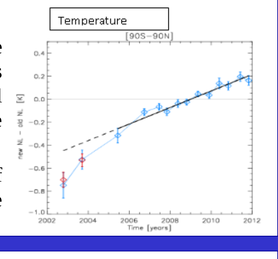


The nonlinearity of the detectors in the long wavelength channels (685 - 1500 cm^{-1}) has changed during the mission due to the aging of the detectors. **V7 radiances** have been **corrected using in-flight measurements of the time dependent parameters of the nonlinearity correction** (see next box).



Left plot: Time dependence of the slope of the scatter plot of V7 vs V6 radiances in the spectral regions used for temperature retrieval at altitude 33 km.

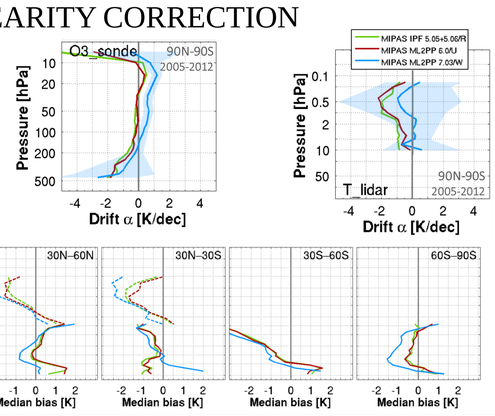
Right plot: Time dependence of the V7-V6 temperature change due to the change in the radiance



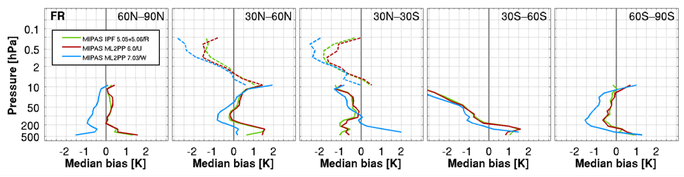
IMPACT OF NONLINEARITY CORRECTION

At least a partial **correction of the drift due to the time variability of detector nonlinearities** (see [5]) has been obtained.

Here a comparison of the average linear temperature drift relative to the lidar (right) and sonde (left) is shown ([4]).

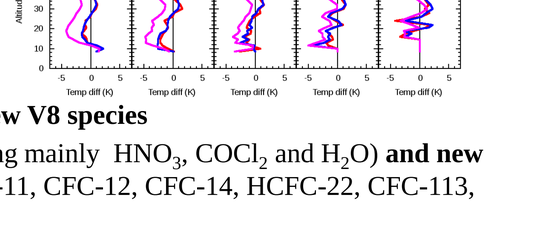


…**but** a negative bias of 0.5-1°K in retrieved temperature from FR measurements is introduced.



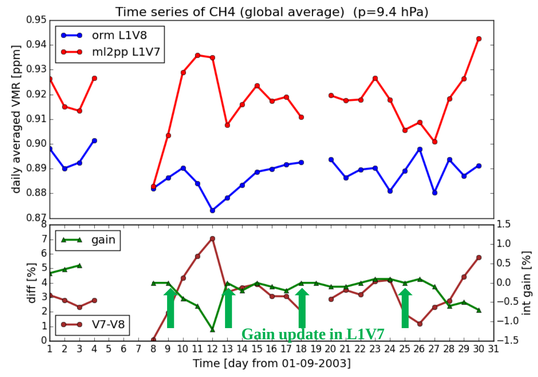
MAIN IMPROVEMENTS IN V8 wrt V7 DATA

Modelling of horizontal variabilities with gradients: it leads to a reduction in the ascending - descending differences in Temperature and retrieved target species. An example for Temperature is shown.



Optimal Estimation used **for the analysis of the new V8 species**

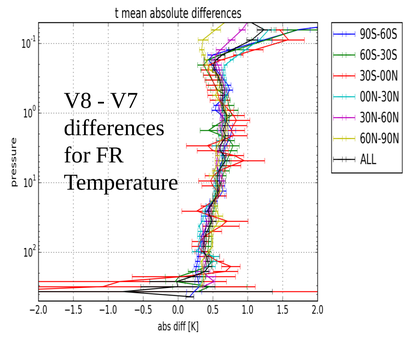
New spectroscopic database MIPAS V4.5 (impacting mainly HNO_3, $COCl_2$ and H_2O) **and new cross-section files for some heavy molecules** (CFC-11, CFC-12, CFC-14, HCFC-22, CFC-113, $ClONO_2$, HNO_4) (see next box).



Use of measured daily gain instead of updating the gain weekly (as in L1 V7 data). This allows to better handle the changes in the gain occurring especially in band B, as a consequence the discontinuities in the timeseries of retrieved profiles from band B (CH_4, N_2O and N_2O_5) are reduced. An example for CH_4 is shown.

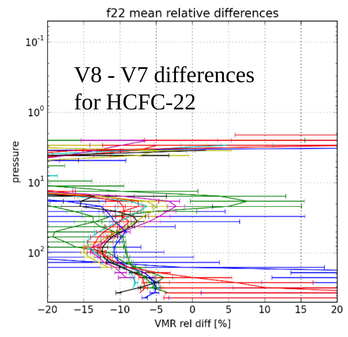
Improved correction of time variability in detector nonlinearities that leads to a reduction of the negative bias present in FR V7 temperatures (see next box).

V8 – V7 DELTA-ANALYSIS (preliminary)



In the FR measurements a positive temperature bias of V8 wrt V7 corrects for the negative bias of V7

The use of the new cross-sections for HCFC-22 recently measured by J. Harrison [6] leads to a **5-15 % reduction in the retrieved HCFC-22**



Other differences in the products are under investigation.

CONCLUSIONS

Ten years of MIPAS measurements represent a very interesting dataset for understanding atmosphere climatology from the upper troposphere to the mesosphere, including trends in composition and variability, as a reference for middle atmosphere ozone and general circulation as well as improvement of tropospheric composition retrievals.

Significant improvements have been recently implemented in both L1 and L2 ESA processors, as well as in the auxiliary data. MIPAS ESA V7 products are characterized by improved CFC-11, improved altitudes and a reduced time dependent calibration error due to non-linearities, leading to a reduced instrumental drift, important for the study of trends with MIPAS products.

MIPAS ESA products V8 will take advantage of the new spectroscopic database and cross-sections for heavy molecules, it will properly handle horizontal gradients, it will further correct the instrumental drift due to the time dependent nonlinearities, it will reduce discontinuities in the time series of retrieved species by exploiting daily measurements of the gain. A total of 22 species will be included in the L2 V8 products.

Bibliography

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